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A Study of the Free-Floating Phytoplankton of the Embarras River and Polecat Creek, Coles County, IL

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A STUDY OF THE FREE-FLOATING PHYTOPLANKTON OF THE EMBARRAS RIVER AND POLECAT CREEK, COLES COUNTY, IL

(TITLE)

BY

RICHARD GARY FRIED

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1980

YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING THIS PART OF THE GRADUATE DEGREE CITED ABOVE

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A STUDY OF THE FREE-FLOATING PHYTOPLANKTON OF THE EMBARRAS RIVER AND POLECAT CREEK, COLES COUNTY, ILLINOIS

BY

RICHARD GARY FRIED

B.S., Bradley University, 1978

ABSTRACT OF A THESIS

Submitted in partial fulfillment of the
requirements for the degree of Master of Science
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ABSTRACT

An investigation of 2 sites on the Embarras River and 1 site on Polecat Creek was undertaken for a one-year period. Special emphasis was given to phytoplankton species and to their seasonal variations. Approximately 170 species from 8 divisions of algae were encountered during the one-year period.

Temperature was found to have no direct correlation with algal periodicity.

Palmer's organic pollution genus index was applied to determine the approximate levels of organic pollution at all three sampling sites. Only one time during the year (10/1/79), did all three sites suggest high organic pollution.

Transeau's 6 ecological groups were used to categorize all dominant organisms in the study. Even though the organisms in the present study were not the same as those encountered by Transeau they were easily categorized.

An index was designed to determine the relative importance of each organism or group of organisms encountered in the study. The index showed 14 organisms to be abundant, with Cyclotella glomerata, Nitzschia palea, and the unidentifiable chlorophycean coccoids being most abundant.

There was no significant qualitative contribution, but there was a slight quantitative contribution of the algal flora by Polecat Creek, to the Embarras River on certain sampling dates. Also, the data show that the presence of algal reproduction governed the algal flora as it moved down the river.

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INTRODUCTION

The algal flora of streams and rivers have been extensively reviewed in the past. Authors have discussed the algae with reference to their taxonomy studies (Transeau, 1913; Britton, 1944; Phinney, 1946; Hooper, 1947; Dillard, Weik & Mohlenbrock, 1963; Collins & Kalinsky, 1977), to their behavioral patterns (Transeau, 1916; Butcher, 1932), and to the physical and chemical parameters which govern the phytoplankton (Blum, 1956, 1960; Cooke, 1956; Round, 1964, 1973; Palmer, 1969; Whitford, 1960).

The Embarras River and Polecat Creek in Coles County, Illinois have been the sites of several studies, 3 of which are relatively recent (Durham & Whitley, 1971; Anonymous, 1972: Lin *et al*., 1978) and primarily involve biological, physical, and chemical parameters. However, little is known about the specific quantitative and qualitative composition of the algal flora of these two waters.

The intent of the present study is to characterize the phytoplankton of the Embarras River and Polecat Creek and to determine what, if any, quantitative and/or qualitative contribution Polecat Creek might make to the algal flora of the river.

BACKGROUND AND LITERATURE REVIEW

The Embarras River and Polecat Creek flow through an agricultural area in east-central Illinois and have been the site of several plankton studies in recent years. One of these studies was undertaken as part of a county-wide stream survey in which numerous biological, physical, and chemical parameters of the two streams were measured in conjunction with the Water Pollution Control Research Series (Durham and Whitley, 1971). The U.S. Army Corps of Engineers (1972) attempted to note the physiographic, biological, and anthropological elements in the impact area of the proposed Lincoln Lake in Cumberland, Coles, and Douglas counties in east-central Illinois. The study included the Embarras River and Polecat Creek, and noted the organisms which may be endangered or adversely affected by the impoundment. Lin et al. (1978) conducted a study, from 1971 to 1976, of the algae in selected Illinois streams. This study involved the Embarras River, but excluded Polecat Creek. Data evaluation and discussion of algal composition and density were made for all the streams in the survey.

In the present investigation, 3 sites were selected in order to study possible qualitative and quantitative phytoplankton contributions, of Polecat Creek to the Embarras River. Figure 1 shows the location of the three sampling sites. Site 1 is located on the Embarras River about 1 mile above the mouth of Polecat Creek. Site 2 is located on Polecat Creek about 2 miles upstream from its point of entry into the Embarras and site 3 is located on the Embarras about 1 mile downstream from the mouth of Polecat Creek. Bridges at all three sites facilitated sampling.

STREAM AND RIVER ALGAL COMMUNITIES

The existence of plankton in streams of the United States was apparently first reported about 1892 (see Galtsoff, 1924). Since 1892, numerous investigations have been published on the fresh-water plankton of the streams and rivers of the United States. Exemplary of the numerous major published reports are those of Kofoid (1903, 1908) on the Illinois River, Allen (1913) on the San Joaquin River, Purdy (1923) on the Ohio River, Galtsoff (1924), and Wiebe (1928) on the Mississippi River, Roach (1932) on the Hocking River, Damann (1951) on the Missouri River Basin, Blum (1957) on the Saline River, and Collins and Kalinsky (1977) on the Scioto River.

Stream ecology, although similar in basic principles to that of other bodies of water, is influenced by extreme fluctuations of current. Butcher (1932) considered the algae of any given stream to be composed of two major components, viz., those algae which are free-floating in the water and those which are sessile - either attached to the riverbed or to any object or plant in the water. Potamoplankton is the term given by early researchers to the free-floating algae (see,e.g., Tiffany, 1958) and the attached algae have been grouped according to their various substrates (e.g., epilithic, epiphytic, etc.) and to their growth type (Butcher, 1932).

The attached community has been discussed with reference to running water by Blum (1956, 1960), Cooke (1956), Round (1964, 1973) and Whitford (1960). It consists primarily of microscopic species but, particularly in small streams and on rocky substrata, it also contains a number of more conspicous plants. These include several genera of the Rhodophycophyta (*Lemanea*, *Hildenbrandia*, and *Batrachospermum*), filamentous Chlorophycophyta (*Cladophora*, *Ulothrix*, *Oedogonium*, *Stigeoclonium*, and sometimes *Zygnema* and *Spirogyra*), Chrysophycophyta (*Vaucheria* and *Hydrurus*), Cyanochloronta (Oscillatoria and Phormidium), and diatoms which form conspicuous masses, such as Diatoma, Synedra, and Gomphonema.

Tiffany (1951) stated that the flow rate of a given stream will, to a large extent, determine the flora which will be found in the stream. In the turbulent cool waters of torrents, rapids and waterfalls, attached to rocks and stones occur Lemanea, Compsopogon, Sacheria, Hydrurus, Hildenbrandia, and Batrachospermum. Common in sluggish streams are organisms such as Hydrodictyon, Tribonema, Tetraspora, Draparnaldia, Stigeoclonium, and Ulothrix. According to Blum (1957) and Tiffany (1958), the most common sessile organism found in streams of temperate regions is the filamentous green alga Cladophora. Tiffany (1951) has stated that many organisms in a stream community grow in association with Cladophora, including Aphanochaete, Chamaesiphon, Cocconeis, Navicula, Gomphonema, Spirogyra, Mougeotia, and Rhizoclonium.

Sessile algae of streams are discussed in greater detail by Butcher (1932) who distinguished growth types of sessile algae as follows:

1. The "thalloid" type comprises those algae that are closely appressed and firmly attached by mucilage or other means along a large part of their surface. They are multicellular or colonial forms, e.g., Ulvella, Stigeoclonium farctum, Oncobyrsa.

2. The "Cocconeis" type comprises those diatoms that are attached to the substratum by the whole of one surface, e.g., Cocconeis and possibly some species of Amphora and Cymbella.

3. The "filamentous" type comprises those filamentous algae that are attached to the substratum by a holdfast, e.g., Ulothrix or by a mucilaginous film, e.g., Phormidium.

4. The "stalked" diatom type includes many genera of diatoms all of which are loosely attached to the substratum by a branched or unbranched mucilaginous pedicel (e.g.,

Cymbella and Encyonema) or by a mass of mucilage at one end (e.g., Synedra and Diatoma).

5. The "unattached" type comprises a tremendous number of colonial Chlorophyceae and Myxophyceae, desmids and diatoms that have no obvious method of attachment, e.g., Cyclotella, Scenedesmus, and Closterium.

6. The "motile" type includes all those algae that are obviously adapted to a free-swimming existence because they possess cilia (sic) or flagellae (sic).

Butcher (1932) also states that sessile algae in streams contribute substantially to the makeup of the potamoplankton. This contribution is due to the continual movement of the current which will wash away a certain number of individuals which will, in turn, float downstream. According to Butcher (1932) the contribution of riverbed algae to the potamoplankton is far more important than any of the sources of potamoplankton listed by Krieger (1927, according to Butcher, 1932), who listed what he believed to be the actual sources of potamoplankton as follows:

1. The districts adjoining the source.
2. The heloplankton (i.e., from pools on the system).
3. The limnoplankton (i.e., from lakes on the system).
4. Drains and tributaries.

Butcher (1932) greatly stressed the importance of the sessile algae to the free-floating algal vegetation; however, in a later paper (1940) he indicated that in other studies, the potamoplankton have shown considerably less resemblance to the sessile algae. Apparently, therefore, the potamoplankton is composed of both sessile algae and algae contributed by the sources mentioned above by Krieger.

Tiffany (1958) has postulated that phytoplankton are evidently capable of multiplication *en route* downstream and, therefore, the slower a stream moves, the greater will be the number of individuals in the stream. Hynes (1970) also states that many of the organisms comprising river plankton are truly potamoplanktonic and capable of reproduction in the rivers.

A large number of studies have been published on the planktonic organisms of rivers world-wide. From these investigations it is clear that the phytoplankton is always more abundant than the zooplankton and that diatoms are almost always dominant (Hynes, 1970). The most frequently encountered truly planktonic diatom genera are *Asterionella*, *Tabellaria*, *Fragilaria*, and the centric forms *Melosira*, *Cyclotella*, *Coscinodiscus*, and *Stephanodiscus*. Benthic diatoms which contribute large numbers to the potamoplankton include the genera *Synedra*, *Navicula*, *Diatoma*, and *Surirella* (Palmer, 1964, Hynes, 1970). According to Hynes (1970), during the summer, or in permanently warm rivers, the above genera are joined by a variety of truly planktonic Chlorophyceae, such as *Scenedesmus*, *Ankistrodesmus*, *Pediastrum*, and *Chlamydomonas*, and a variety of non-chlorophycean flagellates including *Cryptomonas*, *Mallomonas*, *Trachelomonas*, *Euglena*, *Synura*, and *Ceratium*. Further, it is not uncommon to encounter genera of the Cyanochloronta, such as *Gomphosphaeria*, *Aphanizomenon*, *Anacystis*, *Anabaena*, and *Lyngbya* when the water is warm.

Swale (1969) states that when sampling methods which retain the smaller planktonic forms are used, it appears that the dominant components of the free-floating phytoplankton of large rivers are usually centric diatoms. Round (1973) has supplemented this concept by stating that in relatively slow-flowing rivers, such as the Thames River in England, some species, such as Stephanodiscus hantzschii, maintain populations perennially. Transeau (1916), in his classical report on algal periodicity based on observations of algae in central Illinois, determined that phytoplankton encountered in a river usually appear with predictable regularity. He has classed the freshwater algae into six natural groups according to their periodicity. The six groups are as follows:

1. The "winter annuals," which begin their vegetative activities in autumn and culminate their reproductive activities in March and April.

2. The "spring annuals" start vegetative growth in late autumn or early spring and complete maximum growth and reproduction during May.

3. The "summer annuals" germinate in the spring and undergo maximum reproductive activities in July and August.

4. The "autumn annuals" are most abundant in the fall. These algae begin vegetative development in late spring and continue through the summer. If sexual reproduction is present, it occurs in September and October.

5. The "Perennials" are organisms which have a vegetative cycle that is continuous from year to year. Reproduction may occur at any time, but usually is more abundant during May and June.

6. The "ephemerals" are species which have vegetative cycles of a few days or a few weeks. Their generations succeed one another rapidly during periods of favorable conditions.

TEMPERATURE

According to McCombie (1953), water temperature may be a controlling factor or a lethal factor for phytoplankton. The water temperature controls the rates of metabolism and growth of phytoplankton, but unlike a limiting factor, it does not act through restriction of the supply of energy or materials. Instead, water temperature influences the rate at which the phytoplankton can utilize the limiting nutrients (e.g., CO_2, O_2, inorganic ions).

Pearsall (1923) states that since diatoms are usually most abundant in winter, it has been assumed that they require low temperature for development. However, Kofoid (1903) concluded for the Illinois River that Melosira granulata rarely, if ever, appeared in quantity at temperatures below 15 C, and Allen (1913) concluded in observing the same species that a temperature of 25 C or higher was a favorable factor in the production of maximum growth.

According to Blum (1956), natural waters show a relative uniformity of temperature over a period of time in a given season. Hynes (1970) mentions that rivers normally show little stratification because of their turbulent flow, but temperature over a distance can be altered by local conditions. Hynes also states that small differences between the sides and center, or between one side and the other of the stream have been observed. These differences may be attributed to sunshine on the shallows, inflowing groundwater, or by the water from a tributary hugging the bank on which it entered.

HYDROGEN-ION CONCENTRATION

The hydrogen-ion concentration (pH) of an aquatic environment may act on the rate of some metabolic reactions within the algal cell and in extremes will have a detrimental or lethal effect on the organism (McCombie, 1953). Most temperate streams are alkaline (pH above 7.0) unless they receive something to cause a drop in pH (e.g., acid drainage from mines). Organisms have been classified with regard to their presence in a basic environment (alkaliphilous) or an acidic environment (acidophilous) (Blum, 1956). Butcher (1938) demonstrated that there is a greater abundance of organisms in an alkaline river than in an acid river. Some of the dominant forms encountered in the alkaline river were Cocconeis, Achnanthes, Amphora, Nitzschia, Gomphonema, and Chamaesiphon. Round (1964) noted the same trends as Butcher and listed many of the same organisms. Also, Round mentioned that organisms such as Eunotia spp., Actinella punctata, Frustulia rhomboides, Pinnularia, spp., and Surirella spp. are common to acidic streams.

MATERIALS AND METHODS

Water samples were collected at each of 2 different sites along the Embarras River and 1 site along Polecat Creek near Charleston, Illinois (Fig. 1). One sample was taken from the shore and the other from the middle of the flowing body of water at each site. Samples were collected monthly for the first 4 months and biweekly for the remaining 8 months of the 1-year sampling period (Nov. 1978-Nov. 1979). Unfiltered water from the upper 10cm of flowing water was collected in plastic 1-liter bottles. Water temperature was determined at each site immediately upon collection.

Each 1-liter sample was preserved within 1 hour of collection with 6ml of Acid-Lugol's solution: 1 part iodine, 2 parts potassium iodide, 20 parts water, 2 parts glacial acetic acid (Prescott, 1970). The samples were then stored in the dark at 4-8 C for later quantitative and qualitative analyses.

The phytoplankton were analyzed by means of the membrane filter technique (McNabb, 1960). In this method, a convenient aliquot of each sample (usually 25, 50, or 100 ml) was filtered through a gridded 47-mm diameter Millipore filter disk with a pore size of 0.45 micrometers. The disk was allowed to dry in an incubator at 40 C for a minimum of 24 hours. A rectangular portion of the disk was then cut such that it would fit under a no. 1, 22 x 44-mm glass coverslip. The rectangle was placed in low viscosity (250 centistoke) immersion oil (refractive index 1.5150 at 20 C) on a standard 3 x 1-inch glass slide; more oil was added to cover the rectangle and the coverslip was carefully laid over the rectangle such that air bubbles were avoided. These slides were stored horizontally in the dark at room temperature until analysis.

An oil immersion objective (total magnification 1000X) was used to identify and enumerate the algae within a visual strip, the width of which was that of the diameter of the field of view between two of the grid markings on the filter disk. Only those organisms which were considered alive at the time of preservation were counted. At least one random strip was examined on each filter disk and if a total of 300 organisms had not been tallied, more strips were examined until either (1) at least 300 organisms were tallied or (2) a total of 30 such strips had been examined. The number of organisms counted was converted to no. liter^{-1} according to the following formula:

$$\frac{N_o}{N_s} \cdot \frac{A_s}{D_e \cdot D_s} \quad \frac{100}{V_f} \quad 1000$$

where: N_o = the number of organisms tallied for all strips counted

N_s = the number of strips tallied per sample

A_s = the area in millimeters^2 of one square on the grid (9.6mm^2)

D_e = the distance in millimeters across the field of view using the oil immersion objective (total magnification 1000X). In this study, D_e was 0.175mm.

D_s = the distance in millimeters between two parallel grid markings which in this study was 3.1mm

100 = the number of grid squares through which the aliquots were filtered

V_f = the volume of water filtered in milliliters

1000 = the constant for converting to liters

All organisms were keyed to the species level whenever possible. The following were utilized to identify the organisms: Tiffany and Britton (1951), Patrick and Reimer (1966, 1975), Weber (1971), and Collins and Kalinsky (1977) for the Bacillariophyceae and Smith (1950), Tiffany and Britton (1951), Prescott (1962), Whitford and Schumacher (1969), and Taft and Taft (1971) for the other classes of algae.

The pH was determined at the shore of all three sample sites with a Markson Science, model-88 digital mini-pH-meter. This meter was calibrated to 7.00 and 4.01 with standard buffer solutions and has a resolution of $\pm$ 0.01 pH unit.

RESULTS AND DISCUSSION

PHYTOPLANKTON PERIODICITY - % OCCURRENCE

The data from a one-year analysis of the free-floating phytoplankton of the Embarras River and Polecat Creek are presented in figures 2 through 4 and tables 2 through 4. Examinations of the organisms revealed approximately 170 species from 8 divisions of algae, *viz.*, the Bacillariophycophyta, Chlorophycophyta, Euglenophycophyta, Chrysophycophyta, Pyrrhophycophyta, Cyanochloronta, Cryptophycophyta, and Xanthophycophyta. Species of the Bacillariophycophyta were the most diverse and numerous.

Figure 2 shows the population trends of the divisions of algae (the Bacillariophycophyta, the Chlorophycophyta, and the other groups combined as one) at each sample site during the 1-year sampling period. It is evident that the Bacillariophycophyta was the dominant division encountered throughout most of the study. These findings are in accordance with the observation made by Hynes (1970) that diatoms are generally the most abundant algae found in rivers world-wide.

Chandler (1940) noted that diatom populations exhibit spring and fall pulses; he also indicated that the spring pulse is dominated by pennate diatoms and that the fall pulse is dominated by centric diatoms. Such was also the case in the present study; the Bacillariophycophyta showed population increases during both the spring (3/15/79 - 5/1/79) and in the late summer (7/1/79 - 9/1/79). Furthermore, the data correlate with Chandler's findings in that the spring pulse was dominated by the pennate diatoms (such as *Navicula rhyncocephala*, *Nitzschia palea*, *N. acicularis*, *Gomphonema olivaceum*, and *Surirella ovata*), and the second pulse consisted mainly of centric diatoms (*Cyclotella* glomerata, C. michiganiana, C. memeghiniana, and Actinocyclus niagarae — see Table 3).

In the middle of the second diatom pulse (8/15/79) there was a decrease in the population at both sites on the Embarras; this decrease was accompanied by an increase in the chlorophycophytan population. It was impossible to determine the precise reasons for or causes of this shift.

Smith (1950) stated that, as a general rule, the Chlorophycophyta show pulses during the late spring and early autumn, but also that these pulses are not sharply marked. The data presented in Figure 2 illustrate both such increases. These pulses were primarily due to the presence of Stichococcus bacillaris and unidentifiable chlorophycean coccoids.

The remaining divisions of algae were, for convenience, grouped together as one, since their numbers were sparse. This group showed one pulse during the late autumn; this pulse was dominated by organisms of the Cryptophycophyta and Euglenophycophyta. Coutant (1976) observed the same kind of pulses, dominated by the same divisions, in a study of Riley Creek, another stream in Coles County, Illinois. Also, Morris et al. (1977) published a study of the phytoplankton distribution in Illinois lakes, including Lake Charleston, which is located approximately 2 miles below sample site 3. In their study, a pulse of the Euglenophycophyta was observed during the middle of October in Lake Charleston. The Euglenophycophyta consisted of 55.8% of the population. Therefore, fall pulses of the Cryptophycophyta and Euglenophycophyta seem to be of common occurrence, at least during the past few years, in the lakes, rivers, and streams studied in Coles County, Illinois.

WATER TEMPERATURE AND pH

Figures 3 (Embarras River) and 4 (Polecat Creek) show the relationship of water temperature to the log of the average number of individuals liter^{-1}. All values presented in these figures represent averages of all samples taken on each designated sample date (with the exception of 2/15/79, at which time only one sample was taken at each site due to the presence of excessive ice).

The general trend in the Embarras River (Fig. 3) was that, with certain exceptions, increases in water temperature were accompanied by increases in algal concentration. There were occasions when water temperature and algal concentration did not fit this general trend (e.g., samples taken during August and September, 1979). These variations could have been caused by such factors as rainfall, waterlevel, daylength and nutrient levels, all of which were not measured in the present study but known to be influential (McCombie, 1953; Blum, 1956).

Figure 4 shows the correlation between water temperature and algal concentration for the samples taken from Polecat Creek. The same general trend as seen in the Embarras is evident in the early months, but the exceptions are more dramatic later (i.e., from 7/79 to 9/79). These more extreme variations are probably due to the fact that the creek is smaller and perhaps much shallower during this time, so that the creek is more immediately and dramatically susceptible to environmental stress or change.

The pH was measured only once at each sample site approximately 1 month after the last water samples were taken.

According to Durham and Whitley (1972) the average pH of the Embarras River from 1967-1970 was 8.20 and the average pH for Polecat

Creek during the same time period was 8.35. The data in the present study (table 1) seem to indicate that there is no significant difference in pH, during 12/1/79, between any of the sampling sites. Also, the pH at all 3 sites is about the same as that found by Durham and Whitley for the same time of year.

ORGANIC POLLUTION

Palmer (1969) assembled, from the reports of 165 authors, a composite rating of algae tolerant of organic pollution and 2 algal pollution indices (1 for genera and 1 for species) which can be used to rate water samples for their relative degree (high or low) of organic pollution. Palmer assigned each genus or species a pollution index value ranging from 1 to 6. These values were determined by assigning a number of points to each genus or species according to the position of occurrence on his composite rating of algae tolerant to organic pollution. The higher on the list an organism occurred, the greater the number of points awarded. After the analyses of 165 reports, Palmer calculated the total number of points for each genus or species and designated the highest index values to the organisms with the highest point totals. In Palmer's system, an organism is considered present only when it occurred in numbers greater than 50,000 liter^{-1}. A score of greater than 20 for a water sample signifies high organic pollution, a score of 15-19 suggests probable evidence of high organic pollution, and values of less than 15 indicate low organic pollution. The values from the application of Palmer's pollution index to the planktonic algal genera of the three sample sites are tabulated in table 2. The genus-pollution index was used because many of the genera listed by Palmer occurred in the water samples. The species-pollution index was not used because a majority of the species listed by Palmer was not present in the samples.

The data in table 2 indicates that at only one time during the year (10/1/79), did all three sites show high organic pollution or at least suggest it. On the other hand, a decrease in the index occurred progressively downstream in the Embarras River on 3 occassions (11/15/78, 4/1/79, and 10/15/79). It is interesting to note that rain, which caused noticeable turbidity, had occurred shortly before sampling on all three of these dates. This rain may have acted as a diluent and this possibility would explain the decrease in index values.

The results in Table 2 also give a slight indication that Polecat Creek may be responsible for an increase in the pollution index value of the Embarras River. On 11 out of 18 sample dates, an increase in the pollution index occurred progressively from site 1 (above Polecat Creek) to site 3 (below Polecat Creek). A good example of such an increase can be seen from the samples taken during 5/15/79. The value (9.5) at site 1 indicated that the water probably had very little organic pollution present. When this water was mixed with water of probable organic pollution (15.5) from Polecat Creek, the value at site 3 (15.0), downstream from Polecat Creek, suggested the possibility of organic pollution. Since these index values are based on the presence of certain algal genera, the increase may be caused by a qualitative or quantitative contribution to the algal flora from Polecat Creek or, more likely, by a combination of both.

PHYTOPLANKTON POPULATION AND SEASONAL PERIODICITY

Table 3 lists all of the organisms or groups of organisms which made up 10% or more of the population in any one of the samples taken during the sampling year. The percent occurrence is displayed for every sample taken for each organism or group of organisms listed.

Transeau (1916) published a study of the periodicity of freshwater algae in east-central Illinois. He concluded that the algae can be divided into 6 ecological groups according to their periodic occurrence (Figure 5). The 6 groups are as follows: winter annuals, spring annuals, summer annuals, autumn annuals, perennials, and ephemerals (all of the above groups are discussed in detail in an earlier section).

The data presented in Table 3 show the same periodic trends as described by Transeau. The organisms in the present study were not the same as those encountered by Transeau, but they can be easily categorized into the 6 ecological groups according to their periodicity as follows:

1.	Winter annuals:	*Stephanodiscus astraea* *S. hantzschii* *Gomphonema olivaceum*
2.	Spring annuals:	*Navicula cryptocephala* *N. rhyncocephala* *Nitzschia acicularis* *Surirella ovata*
3.	Summer annuals:	*Actinocyclus niagarae* *Cocconeis pediculus* *Stichococcus bacillaris*
4.	Autumn annuals:	*Cyclotella meneghiniana* *C. michiganiana* unidentifiable chlorophycean flagellates cryptomonads euglenoids
5.	Perennials:	*Cyclotella glomerata*
6.	Ephemerals:	*Nitzschia palea* unidentifiable chlorophycean coccoids

The results in table 3 also show that there was no significant qualitative contribution by the algal flora from Polecat Creek to that of the Embarras River; however, there was a slight quantitative contribution on certain sampling dates. A good example of a quantitative contribution can be seen on the sampling date 11/15/78 for the organisms Navicula rhyncocephala, Nitzschia palea and the unidentifiable chlorophycean coccoids (U.C.C.) as follows:

	Site 1		Site 2		Site 3	
organisms	shore	bridge	shore	bridge	shore	bridge
N. rhyncocephala	3.6	0.9	21.0	19.9	13.2	23.9
N. palea	6.1	2.2	13.4	12.0	10.1	12.1
U.C.C.	6.6	8.0	16.4	17.3	13.8	6.1

Concomitant with the small quantitative contribution from Polecat Creek, another factor, that of algal reproduction (Tiffany, 1958; Hynes, 1970), governs the makeup of the algal flora as it moves down the river. The data presented in table 3, for a given organism on certain sampling dates, show an increase in the percent occurrence from site 1 to site 3. If this increase coincides with an increase in the number of individuals, then algal reproduction can be considered evident. A good example of algal reproduction can be observed with certain species of the truly planktonic genus Cyclotella. For instance, C. meneghiniana during 9/15/79, and C. glomerata or C. michiganiana during 11/1/79 can all be used to show reproduction in the Embarras River as follows:

		Site 1		Site 3	
Organism		shore	bridge	shore	bridge
C. meneghiniana	(% total)	17.4	12.4	32.3	26.4
	(# ml^{-1})	1,375	1,125	8,464	7,143
	(total org. ml^{-1})	7,893	9,071	26,178	27,035
C. glomerata	(% total)	3.1	8.6	13.8	10.1
	(# ml^{-1})	134	369	982	1,464
	(total org. ml^{-1})	4,331	4,274	7,125	14,428
C. michiganiana	(% total)	1.9	3.1	12.5	4.2
	(# ml^{-1})	80	131	893	607
	(total org. ml^{-1})	4,331	4,274	7,125	14,428

However, there are sampling dates when an increase in percent occurrence from site 1 to site 3 is not indicative of algal reproduction; in these cases, the increase in percent occurrence is not accompanied by an increase in the number of individuals.

Reference to Palmer's index (table 2), and to the conclusions formed from table 3, the increase in Palmer's index progressively downstream can now be partially attributed to algal reproduction and a small quantitative algal contribution of Polecat Creek.

COMPOSITE SPECIES LISTING

Table 4 is a composite listing of all phytoplankton encountered during the one-year study of the Embarras River and Polecat Creek. It is obvious from the listing, as expected (Hynes, 1970) that most of the species belong to the Bacillariophycophyta. The author felt a need to determine the relative importance of each organism or groups of organisms. Therefore, an index was designed to estimate the relative importance of a given organism based on percent occurrence. The data used to calculate the index, along with the index values, are given in table 4.

Three categories of percent occurrence were used to group the organisms: occurrence greater than 10% of the population, between 9.9 - 5.0%, and between 4.9 - 0.1%. These arbitrary categories are based on the assumption that 10% or greater occurrence is dominant or abundant, 9.9 - 5.0% is common, and 4.9 - 0.1% is rare.

There were 18 sets of samples taken during the year. Only the highest percent occurrence for each organism in question was recorded for each set of samples. Therefore, the highest possible sum total for the three percent occurrence categories is 18 (the sum total is represented by the category labeled "total" in table 4). The total gives an indication of how often an organism occurred during the sampling year.

The higher the value the greater the number of occurrences per sets of samples.

The index value was then calculated, by first arbitrarily assigning progressively decreasing values to the three categories. The highest occurrence received a value of 3, the middle category a value of 2, and the low occurrence category a value of 1. These values were then multiplied by the number of times an organism occurred in the categories to which the value was assigned. For example, if an organism occurred 18 times in the above 10% category, the number 18 would be multiplied by 3 which was the arbitrary value assigned to that category. Then the products of the three categories were summed to obtain the index values. These arbitrary index values were used to determine relative importance of an organism; 18 or above is considered abundant, values between 17 and 9 are common, and values between 8 and 1 are rare. The higher the index value the greater the relative importance of the organism. The results of the index show 14 organisms to be abundant:

Organism	Index Value
Cyclotella glomerata	51
C. meneghiniana	37
C. michiganiana	26
Cocconeis pediculus	20
Gomphonema olivaceum	26
Navicula cryptocephala	33
N. gracilis	19
N. rhyncocephala	30
Nitzschia acicularis	23
N. palea	46
Surirella ovata	22
unidentifiable chlorophycean coccoids	50
cryptomonads	31
euglenoids	32

There were 3 organisms or groups of organisms which were most abundant (*Cyclotella glomerata*, *Nitzschia palea*, and the unidentifiable chlorophycean coccoids). It is interesting to note the organism

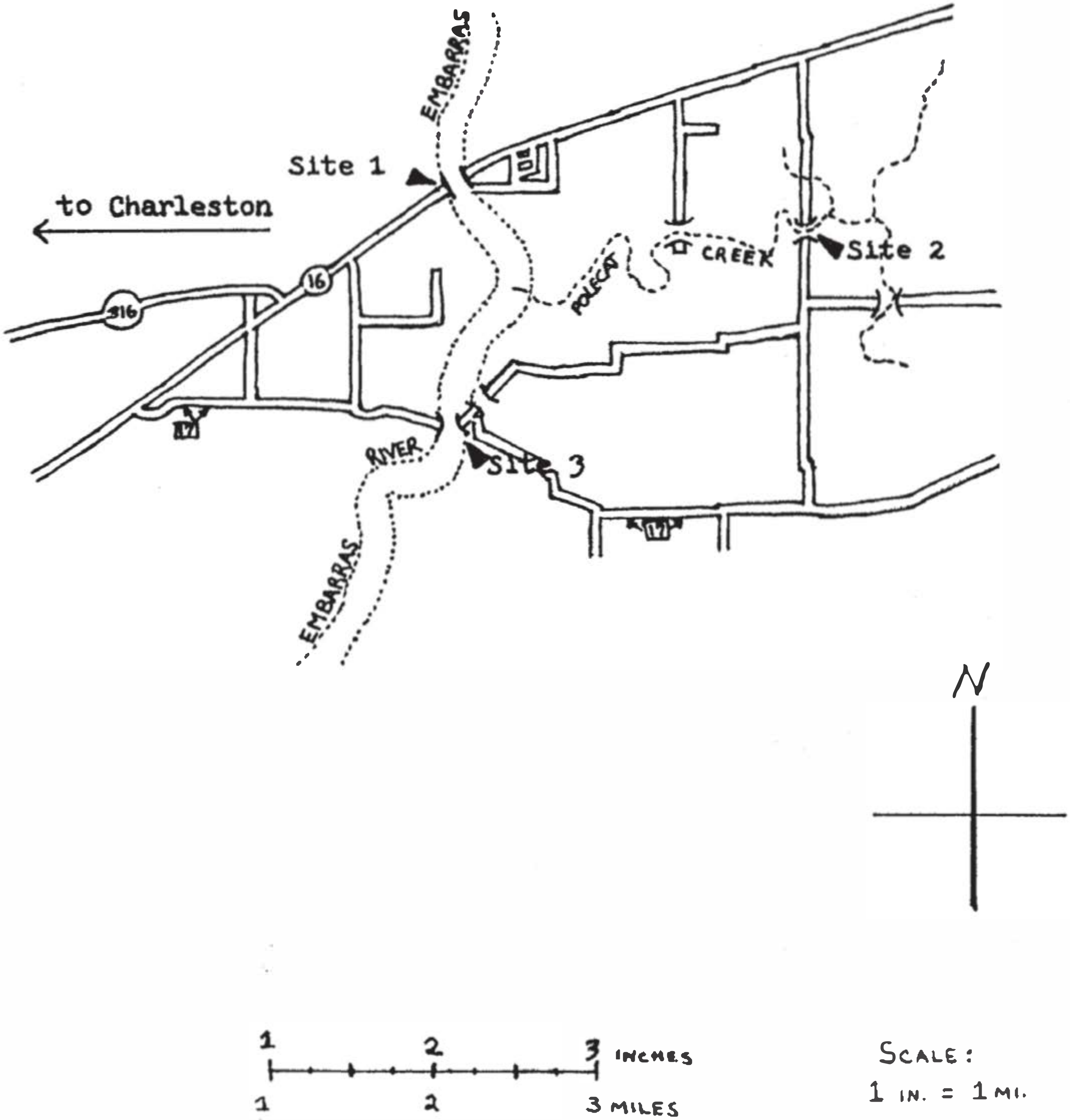
Navicula gracilis is considered abundant, but never during the sampling year did this species comprise more than 9.9% of the population. However, organisms such as Stichococcus bacillaris (17) and Actinocyclus niagarae (14) are only considered common, although they did at one time make up more than 10% of the population.

There are many organisms which are considered common according to the index value, but these organisms never once made up more than 4.9% of the population. Some of these organisms include:

Organism	Index Value
Achnanthes lanceolata	15
Amphora ovalis	15
Cymatopleura solea	10
Fragilaria pinnata	10
Gyrosigma scalproides	11
Navicula dicephala	11
Nitzschia hungarica	16
N. linearis	10
N. sigmoidea	11
Crucigenia quadrata	13
Scenedesmus quadricauda	11

From the results presented, it is clear that the index value can be a useful tool in determining the relative importance of an individual algal species over a period of time. Also, the index can be used with any arbitrary values which are progressively decreasing. Therefore, it is the opinion of the author that this index, or something similar, should be used to accompany any quantified composite listing of algae in order to clarify the relative importance of the organisms resident in the system under study.

Figure 1. Map of the portions of the Embarras River and Polecat Creek studied, along with the surrounding area. The three sample sites are labeled (e.g., Site 1). The solid lines represent roads and the dotted lines represent the river and creek.



EMBARRAS
Site 1
to Charleston
16
316
17
POLECAT
CREEK
Site 2
RIVER
Site 3
17
EMBARRAS
N
1
2
3 INCHES
1
2
3 MILES
SCALE:
1 IN. = 1 MI.

Figure 2. Percent total occurrence of the Bacillariophycophyta (dotted line), Chlorophycophyta (solid line), and all other divisions encountered (dotted dashed line) at all three sample sites along the Embarras River and Polecat Creek, Coles County, Illinois.

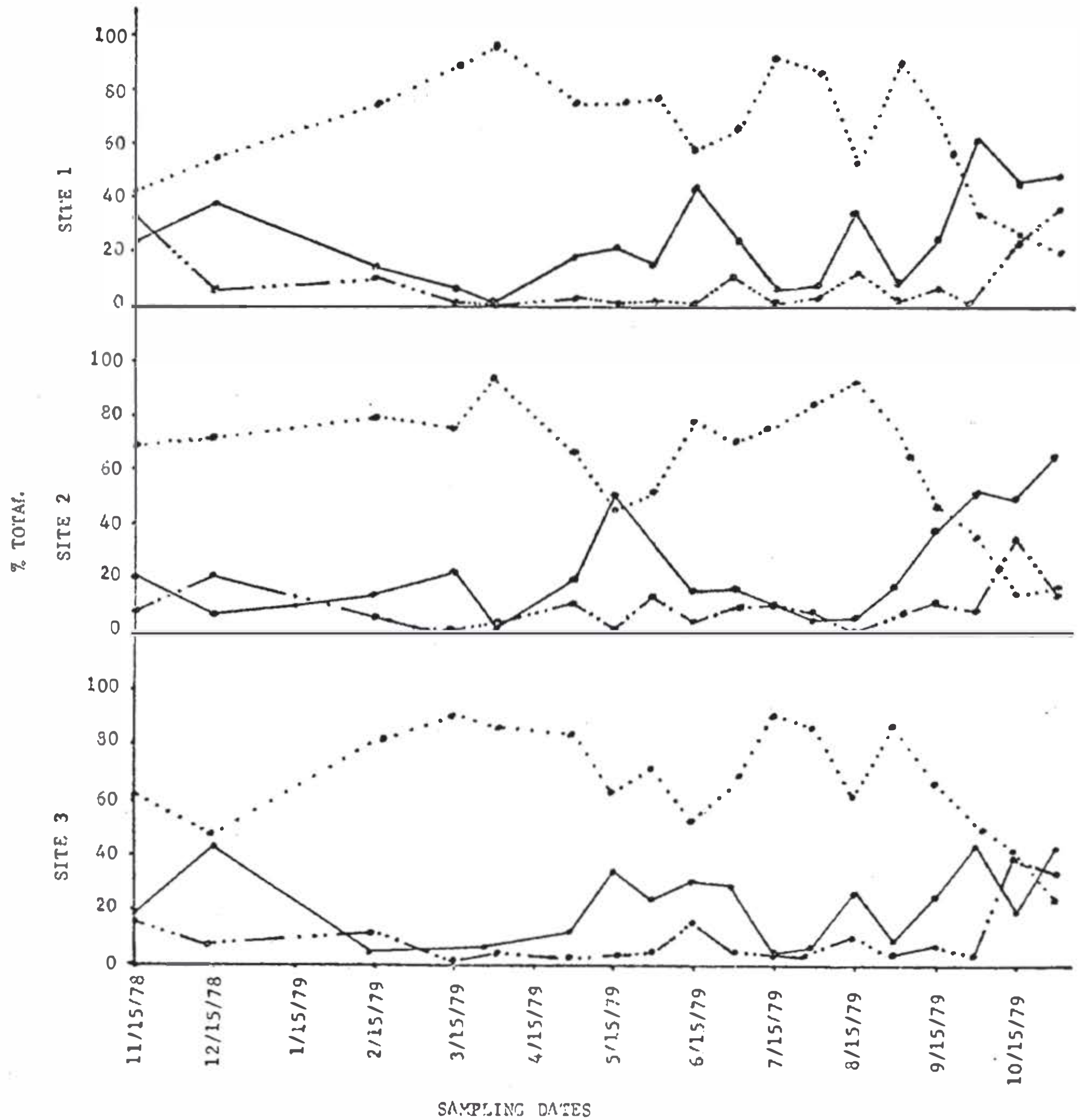

SITE 1
SITE 2
SITE 3
% TOTAL
0
20
40
60
80
100
11/15/78
12/15/78
1/15/79
2/15/79
3/15/79
4/15/79
5/15/79
6/15/79
7/15/79
8/15/79
9/15/79
10/15/79
SAMPLING DATES

Figure 3. Water temperature in ^{o}C (solid line) in relation to the average algal concentration (log $\bar{x}$ liter^{-1}) (dotted line) for the Embarras River, Coles County, Illinois.

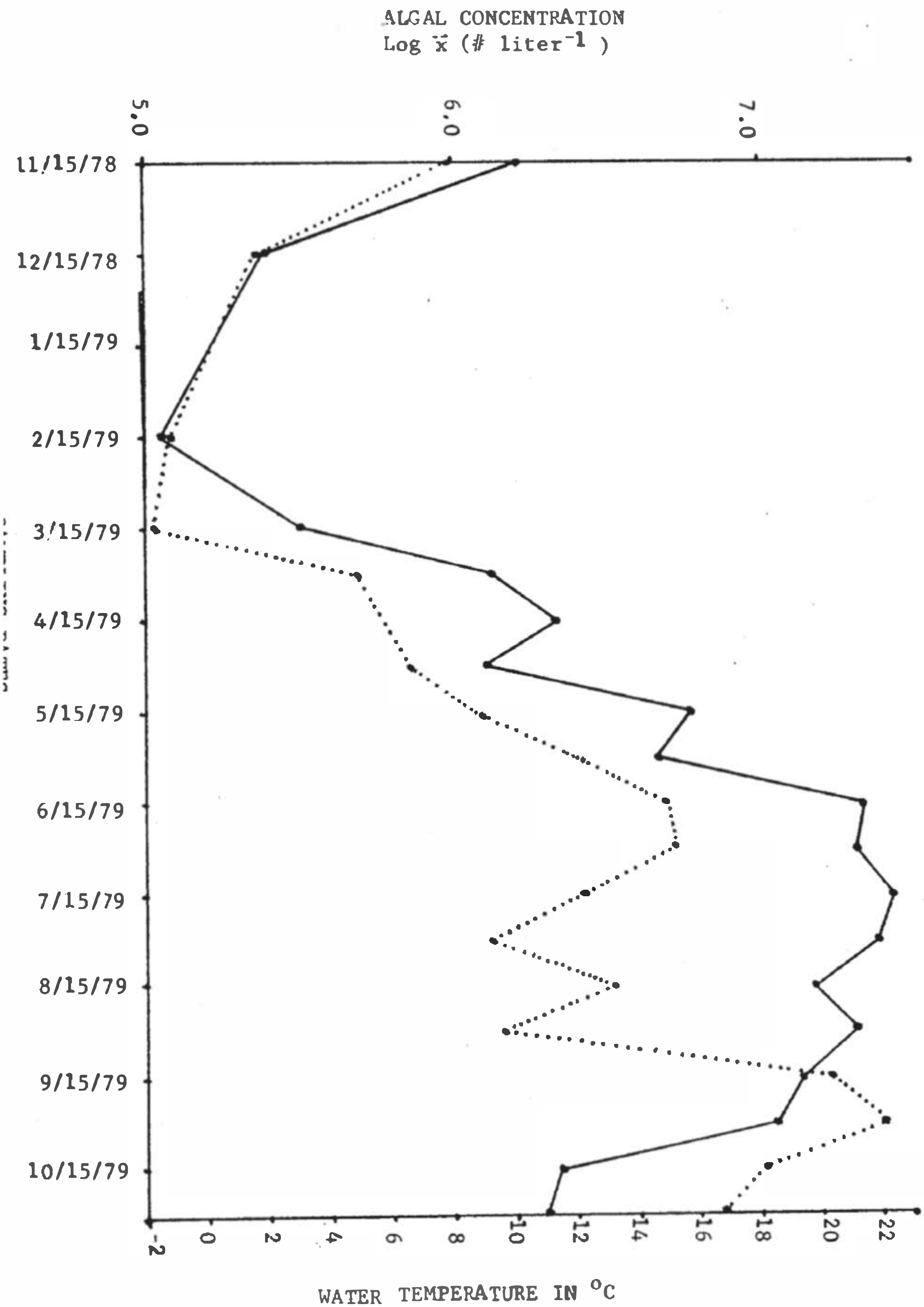

ALGAL CONCENTRATION
Log x̄ (# liter^{-1})
5.0
6.0
7.0
11/15/78
12/15/78
1/15/79
2/15/79
3/15/79
4/15/79
5/15/79
6/15/79
7/15/79
8/15/79
9/15/79
10/15/79
-2
0
2
4
6
8
10
12
14
16
18
20
22
WATER TEMPERATURE IN °C

Figure 4. Water temperature in ^{o}C (solid line) in relation to algal concentration (log $\bar{x}$ liter^{-1}) (dotted line) for Polecat Creek, Coles County, Illinois.

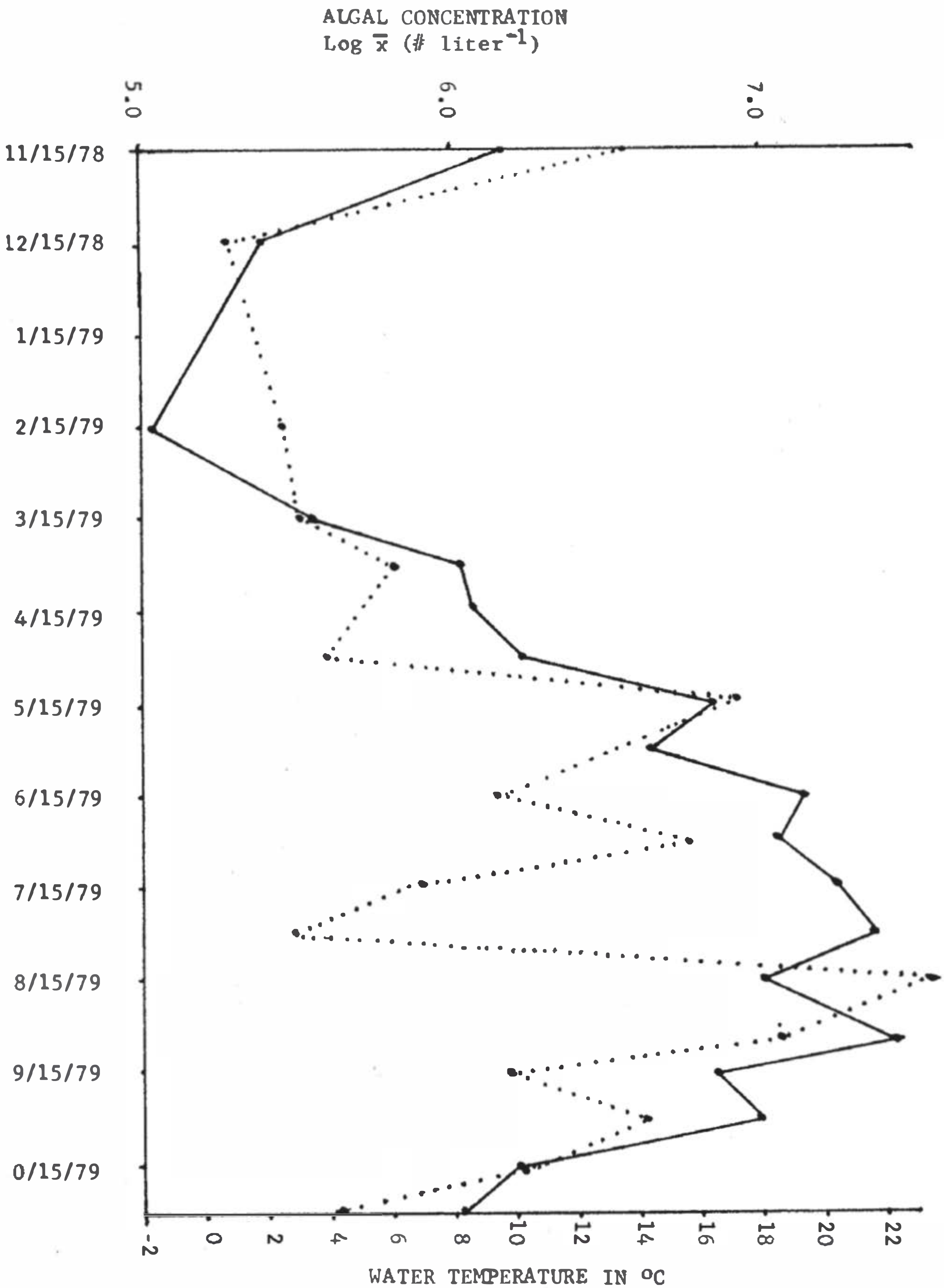

ALGAL CONCENTRATION
Log $\overline{x}$ (# liter^{-1})
5.0
6.0
7.0
11/15/78
12/15/78
1/15/79
2/15/79
3/15/79
4/15/79
5/15/79
6/15/79
7/15/79
8/15/79
9/15/79
0/15/79
-2
0
2
4
6
8
10
12
14
16
18
20
22
WATER TEMPERATURE IN °C

Figure 5. Frequency curves of the six ecological groups of freshwater algae (After Transeau, 1916).

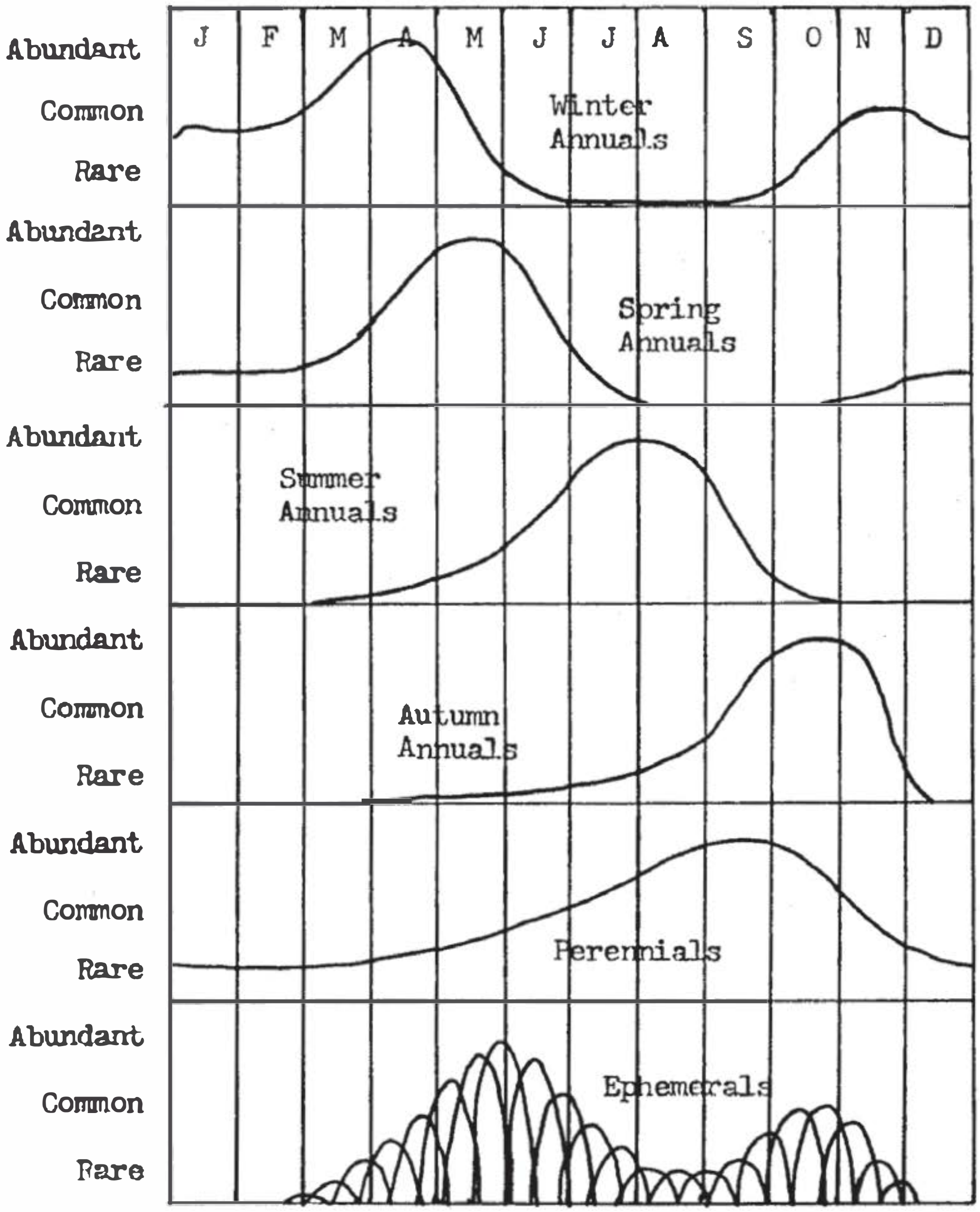

J F M A M J J A S O N D
Abundant
Common
Rare
Winter Annuals
Spring Annuals
Summer Annuals
Autumn Annuals
Perennials
Ephemerals

Table 1. The pH values for all three sample sites along the Embarras River and Polecat Creek, Coles County, Illinois (data of 12/1/79).

SAMPLE SITE	pH READINGS*
1	8.28 @ 1 ^{o}C
2	8.29 @ 0.7 ^{o}C
3	8.40 @ 1 ^{o}C

*The pH readings were taken 12/1/79 from the shore at each sample site.

DATE	SITE 1	SITE 2	SITE 3
11/15/78	6.5	15.5	12.5
12/15/78	6.0	3.0	9.0
1/15/79	---	---	---
2/15/79	0.0	0.5	0.0
3/15/79	0.0	8.0	0.0
4/1/79	4.5	7.5	3.5
4/15/79	---	---	---
5/1/79	5.5	7.5	8.5
5/15/79	9.5	15.5	15.0
6/1/79	9.5	15.0	11.5
6/15/79	7.0	10.0	9.5
7/1/79	9.5	15.0	12.0
7/15/79	15.5	10.0	12.5
8/1/79	10.0	4.5	10.0
8/15/79	12.0	15.0	13.5
9/1/79	10.0	16.0	10.0
9/15/79	10.5	18.0	16.5
10/1/79	15.5	18.0	20.5
10/15/79	15.0	15.5	10.5
11/1/79	13.5	3.0	15.5

Table 2. The values obtained from the application of Palmer's (1969) algal genera organic pollution index at all three sampling sites along the Embarras River and Polecat Creek, Coles County, Illinois.

DATE	SITE 1	SITE 2	SITE 3
11/15/78	6.5	15.5	12.5
12/15/78	6.0	3.0	9.0
1/15/79	---	---	---
2/15/79	0.0	0.5	0.0
3/15/79	0.0	8.0	0.0
4/1/79	4.5	7.5	3.5
4/15/79	---	---	---
5/1/79	5.5	7.5	8.5
5/15/79	9.5	15.5	15.0
6/1/79	9.5	15.0	11.5
6/15/79	7.0	10.0	9.5
7/1/79	9.5	15.0	12.0
7/15/79	15.5	10.0	12.5
8/1/79	10.0	4.5	10.0
8/15/79	12.0	15.0	13.5
9/1/79	10.0	16.0	10.0
9/15/79	10.5	18.0	16.5
10/1/79	15.5	18.0	20.5
10/15/79	15.0	15.5	10.5
11/1/79	13.5	3.0	15.5

Table 3. Dominant species list. The numbers indicate the percent occurrence of each organism comprising 10% or more of the algal population in any one sample during the sampling year for the Embarras River and Polecat Creek, Coles County, Illinois.

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
Actinocyclus niagarae	0.0	0.0	0.0	0.0	0.0	0.0	11/15/78
	0.0	0.0	0.0	0.0	0.0	0.0	12/15/78
	---	---	---	---	---	---	1/15/79
	---	0.0	---	0.0	---	0.0	2/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	3/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	4/1/79
	---	---	---	---	---	---	4/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	5/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	5/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	6/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	6/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	7/1/79
	39.6	35.6	0.0	0.0	36.0	37.9	7/15/79
	11.6	12.9	0.0	0.0	8.3	13.0	8/1/79
	8.4	3.2	0.0	0.0	9.3	2.1	8/15/79
	4.1	7.5	0.3	0.0	5.5	5.7	9/1/79
	3.2	2.0	0.0	0.0	0.7	0.4	9/15/79
	0.0	0.0	0.0	0.0	0.0	0.4	10/1/79
	0.0	0.0	0.0	0.0	0.2	0.0	10/15/79
	0.2	0.0	0.0	0.0	0.0	0.0	11/1/79
Cyclotella glomerata	7.7	9.3	4.2	5.9	3.1	5.7	11/15/78
	2.5	2.5	4.5	3.6	2.5	2.7	12/15/78
	---	---	---	---	---	---	1/15/79
	---	37.3	---	20.7	---	29.7	2/15/79
	1.1	6.6	1.6	1.0	14.3	10.0	3/15/79
	6.7	8.4	6.6	1.3	15.3	5.9	4/1/79
	---	---	---	---	---	---	4/15/79
	18.4	22.2	1.0	2.2	3.1	19.1	5/1/79
	9.4	15.4	8.2	8.8	12.0	13.7	5/15/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLINGS DATES
Cyclotella glomerata con't	4.7	7.3	6.7	14.7	6.8	11.7	6/1/79
	33.0	44.2	14.5	15.2	34.3	42.6	6/15/79
	35.3	33.4	59.0	61.7	40.7	39.6	7/1/79
	3.1	1.5	18.4	15.9	5.7	4.2	7/15/79
	12.0	8.1	9.0	3.2	7.3	9.1	8/1/79
	16.5	17.7	81.4	81.7	11.2	27.4	8/15/79
	26.8	28.5	25.4	21.6	48.7	30.5	9/1/79
	43.2	48.4	14.6	18.6	35.9	27.7	9/15/79
	16.1	15.8	33.7	20.5	23.1	17.1	10/1/79
	17.3	20.0	2.8	2.7	36.2	26.0	10/15/79
	3.1	8.6	1.3	2.3	13.8	10.1	11/1/79
Cyclotella memeghiniana	17.9	17.8	3.9	6.5	6.9	13.1	11/15/78
	0.4	3.2	0.6	2.2	0.0	0.5	12/15/78
	---	---	---	---	---	---	1/15/79
	---	1.2	---	17.4	---	0.9	2/15/79
	1.1	2.8	17.5	0.5	3.6	0.0	3/15/79
	0.8	28.0	3.3	1.3	3.6	3.4	4/1/79
	---	---	---	---	---	---	4/15/79
	2.8	2.0	0.3	1.3	0.3	2.1	5/1/79
	2.2	1.9	1.6	0.3	0.9	1.0	5/15/79
	1.3	0.6	0.9	0.3	0.0	1.7	6/1/79
	2.2	2.4	2.0	3.0	0.3	0.7	6/15/79
	3.3	2.9	1.6	0.9	0.8	0.8	7/1/79
	41.4	41.2	0.7	6.9	29.0	37.9	7/15/79
	26.2	25.8	3.0	0.8	18.2	23.8	8/1/79
	8.9	2.9	6.5	5.7	9.6	7.9	8/15/79
	19.4	15.4	43.3	50.0	9.4	12.7	9/1/79
	17.4	12.4	5.2	2.6	32.3	26.4	9/15/79
	4.1	2.5	4.6	2.5	9.7	3.2	10/1/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
C. memeghiniana con't	2.1	2.4	2.5	3.0	5.6	5.0	10/15/79
	0.8	1.1	1.3	0.3	3.5	2.5	11/1/79
Cyclotella michiganiana	0.0	0.0	0.0	0.0	0.0	0.0	11/15/78
	0.0	0.0	0.0	0.0	0.0	0.0	12/15/78
	---	---	---	---	---	---	1/15/79
	---	0.0	---	0.0	---	0.0	2/15/79
	0.0	0.0	0.0	0.0	0.0	1.1	3/15/79
	0.0	1.6	0.0	0.0	0.5	1.7	4/1/79
	---	---	---	---	---	---	4/15/79
	1.8	0.0	0.3	0.0	0.6	5.0	5/1/79
	2.8	4.7	2.6	0.3	1.2	4.2	5/15/79
	1.3	1.3	1.5	0.7	1.8	0.3	6/1/79
	9.0	6.2	1.7	2.0	6.9	4.1	6/15/79
	24.3	20.9	0.0	0.0	24.7	18.5	7/1/79
	2.8	5.0	5.6	1.4	6.1	5.8	7/15/79
	12.3	18.4	0.7	0.8	8.3	12.7	8/1/79
	0.5	1.6	2.1	4.2	4.4	0.3	8/15/79
	1.9	0.3	0.0	0.0	1.6	0.6	9/1/79
	4.8	2.8	1.5	2.6	1.8	6.5	9/15/79
	14.7	14.1	4.6	0.0	22.0	18.2	10/1/79
	6.0	7.1	0.0	0.0	7.6	6.0	10/15/79
	1.9	3.1	0.0	0.3	12.5	4.2	11/1/79
Stephanodiscus astraea	0.0	0.0	0.0	0.0	0.0	0.0	11/15/78
	0.0	0.0	0.0	0.0	0.0	0.0	12/15/78
	---	---	---	---	---	---	1/15/79
	---	0.0	---	2.9	---	0.0	2/15/79
	0.0	2.8	3.6	0.0	0.0	0.0	3/15/79
	1.7	5.8	9.6	17.0	0.8	0.0	4/1/79
	---	---	---	---	---	---	4/15/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
S. astraea con't	0.0	0.0	0.0	0.0	0.0	0.0	5/1/79
	0.0	0.3	0.0	0.0	0.0	0.0	5/15/79
	0.0	0.3	0.0	0.0	0.0	0.0	6/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	6/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	7/1/79
	0.0	0.0	0.0	0.0	0.0	0.3	7/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	8/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	8/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	9/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	9/15/79
	0.0	0.0	0.0	0.0	0.5	0.4	10/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	10/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	11/1/79
Stephanodiscus hantzschii	0.0	0.0	0.0	0.0	0.0	0.0	11/15/78
	0.0	0.0	0.0	0.0	0.0	0.0	12/15/78
	---	---	---	---	---	---	1/15/79
	---	0.0	---	0.0	---	0.0	2/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	3/15/79
	10.8	0.0	0.0	0.0	0.0	0.0	4/1/79
	---	---	---	---	---	---	4/15/79
	0.0	0.0	0.0	0.0	0.0	0.7	5/1/79
	0.0	2.2	0.0	0.0	0.0	0.0	5/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	6/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	6/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	7/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	7/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	8/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	8/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	9/1/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
S. hantzschii con't	0.0	0.0	0.0	0.0	0.0	0.0	9/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	10/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	10/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	11/1/79
Cocconeis pediculus	0.0	0.0	0.3	2.1	0.3	0.0	11/15/78
	0.0	0.6	0.0	1.4	0.4	0.0	12/15/78
	---	---	---	---	---	---	1/15/79
	---	0.0	---	0.0	---	0.0	2/15/79
	1.1	0.0	0.3	0.0	2.4	10.0	3/15/79
	0.8	1.3	4.6	3.6	1.5	0.0	4/1/79
	---	---	---	---	---	---	4/15/79
	1.1	0.7	1.0	0.9	0.0	0.7	5/1/79
	0.6	0.0	0.3	0.0	0.3	0.0	5/15/79
	0.3	0.0	0.0	0.0	0.0	0.0	6/1/79
	0.0	0.6	0.3	1.7	0.8	0.0	6/15/79
	0.0	0.0	0.0	0.3	0.0	0.0	7/1/79
	0.0	0.6	3.9	4.1	0.0	0.6	7/15/79
	1.3	1.0	10.4	13.7	1.7	3.3	8/1/79
	0.3	0.0	0.0	0.0	0.5	0.0	8/15/79
	0.3	0.3	0.0	0.0	0.0	0.3	9/1/79
	0.2	0.0	0.3	0.7	0.0	0.0	9/15/79
	0.0	0.0	0.0	0.5	0.0	0.0	10/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	10/15/79
	1.2	0.0	0.3	0.3	0.0	0.0	11/1/79
Gomphonema olivaceum	1.0	0.0	1.3	1.8	0.3	0.6	11/15/78
	2.1	1.9	6.8	6.5	1.2	0.5	12/15/78
	---	---	---	---	---	---	1/15/79
	---	1.2	---	13.6	---	2.7	2/15/79
	9.0	5.7	5.5	9.1	7.1	4.4	3/15/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
G. olivaceum con't	13.3	7.7	12.5	17.9	8.7	6.8	4/1/79
	---	---	---	---	---	---	4/15/79
	1.4	3.4	9.6	10.6	1.9	3.2	5/1/79
	2.5	0.6	0.7	0.3	0.3	0.7	5/15/79
	0.0	0.0	0.3	0.7	0.3	0.6	6/1/79
	0.0	0.0	2.3	1.3	0.3	0.3	6/15/79
	0.0	0.0	0.0	0.3	0.0	0.0	7/1/79
	0.0	0.3	1.0	3.1	1.0	0.3	7/15/79
	1.0	1.3	3.7	4.8	1.0	2.9	8/1/79
	0.8	0.0	0.0	0.0	0.8	0.0	8/15/79
	1.3	0.9	0.3	0.3	0.0	0.0	9/1/79
	0.2	0.0	0.9	0.7	0.0	0.0	9/15/79
	0.0	0.0	0.3	0.0	1.1	0.0	10/1/79
	0.0	0.0	0.3	0.3	0.2	0.0	10/15/79
	1.9	0.0	0.3	0.0	0.3	0.0	11/1/79
Navicula cryptocephala	1.0	0.0	3.6	0.9	3.8	2.5	11/15/78
	1.7	0.6	7.4	5.1	2.1	2.2	12/15/78
	---	---	---	---	---	---	1/15/79
	---	0.0	---	4.1	---	2.7	2/15/79
	1.1	0.0	6.8	12.7	2.4	13.3	3/15/79
	9.2	1.0	10.6	7.6	3.6	1.7	4/1/79
	---	---	---	---	---	---	4/15/79
	7.8	7.0	8.0	5.0	9.0	6.0	5/1/79
	2.5	1.6	12.7	2.6	4.3	2.0	5/15/79
	0.6	0.0	2.7	8.8	4.1	0.0	6/1/79
	0.9	0.0	14.2	9.6	0.3	0.0	6/15/79
	0.3	0.0	1.9	2.6	0.3	0.0	7/1/79
	0.6	1.5	12.5	11.4	3.2	1.0	7/15/79
	5.0	5.5	13.4	21.0	10.3	7.2	8/1/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
N. cryptocephala con't	0.8	0.0	0.0	0.1	1.1	0.3	8/15/79
	3.8	4.4	1.0	2.3	2.6	4.1	9/1/79
	0.2	0.0	3.4	4.9	0.3	0.0	9/15/79
	0.2	0.0	1.6	1.3	1.9	0.0	10/1/79
	0.0	0.0	1.6	1.5	0.0	0.0	10/15/79
	1.2	0.0	3.0	3.6	1.0	0.0	11/1/79
Navicula rhyncocephala	3.6	0.9	21.0	19.9	13.2	23.9	11/15/78
	18.9	13.4	15.9	13.8	16.1	17.3	12/15/78
	---	---	---	---	---	---	1/15/79
	---	4.8	---	3.7	---	6.3	2/15/79
	15.7	12.3	5.8	10.7	13.1	7.7	3/15/79
	4.2	4.5	6.3	3.1	5.1	5.9	4/1/79
	---	---	---	---	---	---	4/15/79
	3.9	5.9	1.6	1.9	6.5	2.1	5/1/79
	2.8	0.9	5.6	2.6	1.5	0.0	5/15/79
	0.9	0.0	15.2	11.1	0.9	0.0	6/1/79
	0.0	0.0	6.9	7.6	0.0	0.0	6/15/79
	0.0	0.0	0.0	0.6	0.0	0.3	7/1/79
	0.3	0.9	5.6	3.4	0.7	0.6	7/15/79
	1.0	1.6	2.2	3.2	4.0	0.7	8/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	8/15/79
	0.7	0.3	0.0	0.0	0.0	0.0	9/1/79
	0.0	0.0	3.0	5.2	0.1	0.0	9/15/79
	0.0	0.0	1.0	0.8	0.5	0.0	10/1/79
	0.0	0.0	1.6	0.9	0.0	0.0	10/15/79
	0.6	0.3	1.3	0.7	0.0	0.0	11/1/79
Nitzschia acicularis	2.6	2.2	0.3	0.6	1.6	1.0	11/15/78
	2.9	3.2	0.0	0.0	2.9	2.2	12/15/78
	---	---	---	---	---	---	1/15/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
N. acicularis con't	---	0.0	---	0.4	---	0.9	2/15/79
	0.0	4.7	0.6	0.0	1.2	0.0	3/15/79
	1.7	0.3	0.0	0.0	3.1	0.8	4/1/79
	---	---	---	---	---	---	4/15/79
	2.5	1.7	0.6	0.9	5.0	2.1	5/1/79
	28.1	24.2	4.9	4.0	16.0	28.0	5/15/79
	58.1	62.3	4.8	3.3	47.2	48.0	6/1/79
	0.0	0.3	2.0	1.3	0.3	0.2	6/15/79
	0.9	0.9	0.0	0.3	0.0	0.0	7/1/79
	0.6	0.9	0.3	0.0	1.0	0.3	7/15/79
	1.0	0.0	0.0	0.8	0.3	0.3	8/1/79
	7.0	5.5	0.2	0.4	8.7	2.1	8/15/79
	7.6	6.9	0.3	0.6	4.5	8.6	9/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	9/15/79
	0.1	0.1	0.0	0.0	0.0	0.0	10/1/79
	0.0	0.2	0.0	0.0	0.0	0.2	10/15/79
	0.4	0.0	0.0	0.0	0.0	0.0	11/1/79
Nitzschia palea	6.1	2.2	13.4	12.0	10.1	12.1	11/15/78
	16.4	17.8	17.6	15.9	16.9	16.8	12/15/78
	---	---	---	---	---	---	1/15/79
	---	9.6	---	6.6	---	17.1	2/15/79
	23.6	18.9	14.0	15.2	17.9	15.6	3/15/79
	9.2	6.8	6.6	8.9	10.7	13.6	4/1/79
	---	---	---	---	---	---	4/15/79
	8.5	12.9	14.1	9.7	24.6	10.3	5/1/79
	13.1	5.3	6.2	6.3	11.0	6.8	5/15/79
	7.2	6.3	5.7	4.9	6.8	5.1	6/1/79
	5.6	5.9	16.5	13.2	10.2	1.4	6/15/79
	3.0	0.9	2.2	2.0	0.8	1.8	7/1/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
N. palea con't	2.8	1.8	15.1	11.7	2.9	3.9	7/15/79
	2.0	3.2	13.4	8.9	8.3	3.3	8/1/79
	16.2	12.6	0.7	0.3	28.4	5.2	8/15/79
	19.1	19.7	1.3	2.3	10.4	18.1	9/1/79
	0.9	0.0	6.7	5.5	0.1	0.4	9/15/79
	0.2	0.4	1.6	2.3	2.4	0.0	10/1/79
	0.8	0.4	2.5	5.1	0.8	0.0	10/15/79
	1.4	0.0	7.0	5.3	0.8	0.2	11/1/79
Surirella ovata	0.0	0.0	0.3	0.9	0.0	0.3	11/15/78
	0.8	0.0	2.8	0.0	0.0	0.0	12/15/78
	---	---	---	---	---	---	1/15/79
	---	1.2	---	0.8	---	2.7	2/15/79
	5.6	5.7	6.2	7.1	6.0	7.7	3/15/79
	15.0	9.6	10.2	11.2	19.4	21.2	4/1/79
	---	---	---	---	---	---	4/15/79
	8.1	8.5	12.8	13.8	23.7	7.1	5/1/79
	1.6	1.9	3.9	2.0	1.5	1.3	5/15/79
	0.0	0.3	0.9	2.0	1.2	0.3	6/1/79
	0.0	0.6	5.6	4.3	0.5	0.0	6/15/79
	1.5	0.3	1.6	0.3	1.1	0.0	7/1/79
	0.0	0.0	3.9	2.8	0.3	0.3	7/15/79
	0.0	0.7	0.7	1.6	3.0	1.3	8/1/79
	0.0	0.0	0.0	0.0	0.3	0.0	8/15/79
	0.0	0.0	0.0	0.0	0.3	0.6	9/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	9/15/79
	0.0	0.0	0.0	0.3	0.0	0.0	10/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	10/15/79
	0.2	0.0	0.3	0.0	0.0	0.0	11/1/79
Chlorophycean coccoids	6.6	8.0	16.4	17.3	13.8	6.1	11/15/78

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
Chlorophycean coccoids con't	33.6	36.9	5.7	1.4	42.6	37.8	12/15/78
	---	---	---	---	---	---	1/15/79
	---	8.4	---	2.9	---	3.6	2/15/79
	10.1	11.3	17.9	23.4	6.0	3.3	3/15/79
	5.0	0.0	1.0	0.0	1.0	8.5	4/1/79
	---	---	---	---	---	---	4/15/79
	24.0	7.8	20.1	17.5	4.7	20.9	5/1/79
	17.2	21.4	38.6	58.8	35.9	27.0	5/15/79
	19.7	14.6	33.1	32.6	19.5	20.6	6/1/79
	15.0	15.7	10.6	16.2	4.9	13.1	6/15/79
	13.7	14.6	17.1	13.2	10.5	21.1	7/1/79
	3.1	4.7	7.9	7.2	4.1	3.5	7/15/79
	8.0	6.8	5.2	5.6	6.3	7.8	8/1/79
	29.3	36.1	3.3	4.9	18.3	33.5	8/15/79
	8.0	6.9	13.7	11.3	8.1	10.5	9/1/79
	18.8	22.0	30.2	30.9	8.6	12.7	9/15/79
	54.7	62.2	36.6	53.7	24.7	53.4	10/1/79
	38.5	44.8	43.2	43.4	11.8	20.8	10/15/79
	47.8	49.9	49.3	64.5	38.3	41.4	11/1/79
Chlorophycean flagellates	15.8	13.3	4.6	3.8	9.7	5.4	11/15/78
	1.7	2.5	2.8	5.1	4.5	2.2	12/15/78
	---	---	---	---	---	---	1/15/79
	---	4.8	---	3.3	---	1.8	2/15/79
	2.2	0.0	0.0	1.0	0.0	4.4	3/15/79
	0.0	2.6	1.7	1.3	3.1	0.0	4/1/79
	---	---	---	---	---	---	4/15/79
	0.0	7.0	0.0	1.6	0.0	0.0	5/1/79
	0.0	0.0	0.0	3.4	0.0	0.0	5/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	6/1/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
Chlorophycean flagellates con't	0.0	0.0	0.0	0.0	0.0	0.0	6/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	7/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	7/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	8/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	8/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	9/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	9/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	10/1/79
	0.0	0.0	0.0	0.0	0.0	0.0	10/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	11/1/79
Stichococcus bacillaris	0.0	0.0	0.0	0.0	0.0	0.0	11/15/78
	0.0	0.0	0.0	0.0	0.0	0.0	12/15/78
	---	---	---	---	---	---	1/15/79
	---	0.0	---	0.0	---	0.0	2/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	3/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	4/1/79
	---	---	---	---	---	---	4/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	5/1/79
	0.0	2.5	0.0	0.0	1.5	1.6	5/15/79
	0.0	0.3	0.0	0.0	1.2	0.9	6/1/79
	26.2	19.0	0.3	5.0	17.0	19.6	6/15/79
	9.1	7.1	3.5	1.5	15.2	9.6	7/1/79
	0.0	0.0	0.0	0.0	0.0	0.3	7/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	8/1/79
	1.4	0.3	2.7	2.2	0.0	0.3	8/15/79
	0.6	0.0	0.3	1.0	0.0	0.0	9/1/79
	4.3	0.0	0.0	0.0	13.2	13.5	9/15/79
	4.3	1.6	0.0	0.0	3.8	1.6	10/1/79
	0.0	0.3	0.0	0.0	0.0	0.0	10/15/79
	0.0	0.3	0.0	0.0	0.0	0.0	11/1/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
Cryptomonads	14.8	32.0	6.9	6.2	18.6	9.2	11/15/78
	2.1	7.6	11.9	15.2	4.1	6.5	12/15/78
	---	---	---	---	---	---	1/15/79
	---	9.6	---	3.3	---	6.3	2/15/79
	0.0	0.0	0.6	1.0	0.0	0.0	3/15/79
	3.3	1.0	2.6	1.8	1.0	4.2	4/1/79
	---	---	---	---	---	---	4/15/79
	0.4	0.0	2.9	0.6	0.0	2.1	5/1/79
	0.3	1.3	1.0	1.4	0.6	0.0	5/15/79
	1.3	1.3	1.8	3.6	2.1	3.7	6/1/79
	0.6	0.0	1.7	0.3	16.2	13.4	6/15/79
	3.6	14.6	1.6	2.9	3.6	4.9	7/1/79
	0.0	0.3	0.0	0.7	1.0	1.0	7/15/79
	0.0	0.0	0.0	0.0	0.0	0.0	8/1/79
	0.6	0.3	0.0	0.2	0.0	1.8	8/15/79
	0.0	0.6	0.3	1.0	1.0	0.6	9/1/79
	1.8	6.9	3.0	6.5	3.4	5.1	9/15/79
	1.4	0.8	1.6	1.8	0.5	1.7	10/1/79
	17.0	10.5	24.6	18.6	14.3	16.1	10/15/79
	32.6	30.6	8.3	5.9	24.3	32.2	11/1/79
Euglenoids	10.7	7.6	2.6	2.9	5.3	2.5	11/15/78
	1.7	1.3	5.1	5.1	0.0	4.3	12/15/78
	---	---	---	---	---	---	1/15/79
	---	6.0	---	1.2	---	6.3	2/15/79
	4.5	1.9	1.0	0.5	1.2	1.1	3/15/79
	0.0	0.0	0.7	1.8	0.0	1.7	4/1/79
	---	---	---	---	---	---	4/15/79
	6.7	1.7	6.7	0.9	0.0	2.5	5/1/79
	1.3	1.3	2.3	2.0	1.8	2.0	5/15/79

TAXA	SITE 1 shore	SITE 1 bridge	SITE 2 shore	SITE 2 bridge	SITE 3 shore	SITE 3 bridge	SAMPLING DATES
Euglenoids con't	1.3	2.2	9.6	6.8	1.2	0.6	6/1/79
	0.6	0.0	3.0	3.0	0.5	1.6	6/15/79
	0.9	2.3	3.8	7.9	0.8	1.8	7/1/79
	1.8	1.5	6.3	3.4	4.1	1.3	7/15/79
	2.3	1.9	3.7	3.2	2.3	3.9	8/1/79
	5.3	14.2	0.5	0.2	4.6	11.9	8/15/79
	1.3	1.3	2.6	0.3	1.3	1.6	9/1/79
	2.9	2.6	6.4	3.3	0.4	3.8	9/15/79
	3.4	1.2	4.2	3.8	2.1	2.2	10/1/79
	13.1	9.2	11.0	11.4	17.4	26.0	10/15/79
	4.9	4.7	8.9	3.9	3.3	4.7	11/1/79

Table 4. Composite listing of algae encountered, together with an index showing their relative abundance (index value-see text) for the Embarras River and Polecat Creek, Coles County, Illinois.

TAXA	PERCENT OCCURRENCE			Total	Index Value
	Greater than 10%	9.9%-5.0%	4.9%-0.1%		
I. Division Bacillariophycophyta					
Order Centrales					
Actinocyclus niagarae H.L.Smith	2	2	4	8	14
Coscinodiscus rothii (Juhlin-Dannfelt)Hust.	0	0	1	1	1
Cyclotella glomerata Bachman	16	1	1	18	51
Cyclotella kuetzingiana Thwaites	0	2	2	4	6
Cyclotella memeghiniana Kuetzing	8	3	7	18	37
Cyclotella michiganiana Skvortzow	4	4	6	14	26
Cyclotella stelligera Cleve. et. Grun.	0	0	6	6	6
Melosira granaulata (Ehr.) Ralfs	0	2	10	12	14
Melosira italica (Ehr.) Kuetzing	0	0	1	1	1
Melosira varians C.A. Agardh.	0	0	9	9	9
Stephanodiscus astraea (Ehr.) Grun.	1	0	6	7	9
Stephanodiscus hantzschii Grun.	1	0	2	3	5
Order Pennales					
Achnanthes lanceolata (Breb.) Grun	0	0	15	15	15
Achnanthes minutissima Kutz.	0	0	1	1	1
Amphora ovalis Kutz.	0	0	15	15	15
Anomoeoneis exilis (Kutz.) Cleve.	0	0	1	1	1
Asterionella formosa Hass.	0	1	3	4	5
Caloneis amphisbaena (Bory.) Cleve.	0	0	1	1	1
Caloneis bacillaris (Gregory) Cleve.	0	0	1	1	1
Caloneis silicula (Ehr.) Cleve.	0	0	2	2	2
Caloneis trinodus (Lewis) Boyer	0	0	1	1	1
Cocconeis pediculus Ehr.	2	0	14	16	20
Cymatopleura solea (Breb.) W. Sm.	0	0	10	10	10
Cymbella spp. C.A. Agardh.	0	0	7	7	7

TAXA	PERCENT OCCURRENCE Greater than 10%	9.9%-5.0%	4.9%-0.1%	Total	Index value
Cymbella aequalis W. Sm.	0	0	1	1	1
Cymbella gracilis (Rabenhorst) Cleve.	0	0	1	1	1
Cymbella prostrata (Berkeley) Cleve.	0	0	2	2	2
Cymbella tumida (Breb. ex. Kutz.) V.H.	0	0	1	1	1
Cymbella turgida (Greg.) Cleve.	0	0	2	2	2
Cymbella ventricosa Kutz.	0	0	7	7	7
Diatoma hiemale (Roth) Heib.	0	0	1	1	1
Diatoma vulgare Bory.	0	0	3	3	3
Diploneis puella (Schum.) Cleve.	0	0	3	3	3
Eunotia lunaris (Ehr.) Grun.	0	0	1	1	1
Fragilaria spp. (Lyngbye) Rabenhorst	0	0	1	1	1
Fragilaria capucina Desmazieres	0	0	2	2	2
Fragilaria construens (Ehr.) Grun.	0	0	9	9	9
Fragilaria crotonensis (A.H. Edw.) Kitton	0	0	3	3	3
Fragilaria intermedia Grun.	0	0	1	1	1
Fragilaria pinnata Ehr.	0	0	10	10	10
Fragilaria vaucheriae Kutz.	0	0	1	1	1
Fragilaria virescens Ralfs.	0	0	2	2	2
Frustulia vulgaris (Lyngbye) Rabenhorst	0	0	3	3	3
Gomphonema angustatum (Kutz.) Grun.	0	0	1	1	1
Gomphonema constrictum Ehr.	0	0	1	1	1
Gomphonema olivaceum (Lyngbye) Kutz.	3	2	13	18	26
Gomphonema parvulum (Kutz.) Grun.	0	0	5	5	5
Gyrosigma kuetzingii (Grun.) Cleve.	0	0	9	9	9
Gyrosigma scalproides (Rabenhorst) Cleve.	0	0	11	11	11
Gyrosigma spencerii (Quekett) Cleve.	0	0	2	2	2
Gyrosigma wormleyi (Sullivant) Boyer	0	0	3	3	3
Hantzschia amphioxys (Ehr.) Grun.	0	0	3	3	3
Meridion circulare (Grev.) Ag.	0	0	5	5	5

TAXA	PERCENT OCCURRENCE Greater than 10%	9.9%-5.0%	4.9%-0.1%	Total	Index value
Navicula spp. Bory	0	0	2	2	2
Navicula anglica Ralfs.	0	0	3	3	3
Navicula capitata Ehr.	0	0	1	1	1
Navicula confervacea (Kutz.) Grun.	0	1	5	6	7
Navicula cryptocephala Kutz.	6	3	9	18	33
Navicula cuspidata Kutz.	0	0	2	2	2
Navicula dicephala (Ehr.) W. Sm.	0	0	11	11	11
Navicula gracilis Ehr.	0	2	15	17	19
Navicula hungarica Grun.	0	0	8	8	8
Navicula minima Grun.	0	0	1	1	1
Navicula oblonga Kutz.	0	0	1	1	1
Navicula pelliculosa (Breb.) Hilse	0	0	1	1	1
Navicula placentula (Ehr.) Grun.	0	0	1	1	1
Navicula platystoma Ehr.	0	0	1	1	1
Navicula protracta Grun.	0	0	3	3	3
Navicula pupula Kutz.	0	0	9	9	9
Navicula rhyncocephala Kutz.	4	5	8	17	30
Navicula salinarum Grun.	0	0	4	4	4
Navicula seminulum Grun.	0	0	3	3	3
Navicula viridula Kutz.	0	0	2	2	2
Neidium ladogense (Oestrup) Foged	0	0	1	1	1
Nitzschia acicularis (Kutz.) W. Sm.	2	2	13	17	23
Nitzschia actinastroides (Lemm.) V. Goor.	0	0	3	3	3
Nitzschia amphibia Grun.	0	0	7	7	7
Nitzschia commutata Grun.	0	0	2	2	2
Nitzschia denticula Grun.	0	0	1	1	1
Nitzschia dissipata (Kutz.) Grun.	0	1	13	14	15
Nitzschia filiformis (W. Sm.) Hust.	0	0	3	3	3
Nitzschia hungarica Grun.	0	0	16	16	16

TAXA	PERCENT OCCURRENCE Greater than 10%	9.9%-5.0%	4.9%-0.1%	Total	Index value
Nitzschia linearis (Ag.) W. Sm.	0	0	10	10	10
Nitzschia palea (Kutz.) W. Sm.	12	4	2	18	46
Nitzschia parvula Lewis	0	0	1	1	1
Nitzschia sigmoidea (Nitz.) W. Sm.	0	0	11	11	11
Nitzschia sublinearis Hust.	0	0	1	1	1
Nitzschia tryblionella Hantz.	0	0	9	9	9
Nitzschia vermicularis (Kutz.) Hantz.	0	1	13	14	15
Pinnularia brebissonii Kutz.	0	0	1	1	1
Pleurosigma delicatulum W. Sm.	0	0	1	1	1
Rhoicosphenia curvata Grun.	0	0	8	8	8
Stauroneis smithii Grun.	0	0	1	1	1
Surirella angustata Kutz.	0	0	12	12	12
Surirella biseriata (Ehr.) Breb.	0	0	1	1	1
Surirella linearis W. Sm.	0	0	2	2	2
Surirella minuta Breb.	0	0	2	2	2
Surirella ovata Kutz.	2	2	12	16	22
Surirella robusta Ehr.	0	0	1	1	1
Synedra acus Kutz.	0	0	7	7	7
Synedra cyclopum Brutschy	0	0	1	1	1
Synedra delicatissima W. Sm.	0	0	1	1	1
Synedra parasitica W. Sm.	0	0	7	7	7
Synedra rumpens Kutz.	0	0	2	2	2
Synedra tenera W. Sm.	0	0	4	4	4
Synedra ulna (Nitzsch.) Ehr.	0	1	11	12	13
Tabellaria fenestrata (Lyngb.) Kutz.	0	0	1	1	1
II. Division Chlorophycophyta					
Unidentified coccoids	14	4	0	18	50

TAXA	PERCENT OCCURRENCE Greater than 10%	9.9%-5.0%	4.9%-0.1%	Total	Index value
unidentified colonies	0	0	14	14	14
unidentified flagellates	1	2	4	7	11
unidentified fusiforms	0	0	1	1	1
Order Volvocales					
Gonium pectorale Mueller ?	0	0	2	2	2
Gonium sociale (Dujardin) Warming	0	0	4	4	4
Pandorina morum Bory.	0	0	3	3	3
Order Ulotrichales					
Stichococcus bacillaris Naegeli	3	0	8	11	17
Ulothrix sp. Kutz.	0	0	1	1	1
Order Cladophorales					
Rhizoclonium hieroglyphicum (Ag.) Kutz.	0	0	1	1	1
Order Chlorococcales					
Pediastrum sp. Meyen.	0	0	2	2	2
Pediastrum tetras (Ehr.) Ralfs.	0	0	7	7	7
Coelastrum microporum Naegeli	0	0	1	1	1
Coelastrum sphaericum Naegeli	0	0	5	5	5
Ankistrodesmus falcatus (Corda) Ralfs.	0	1	11	12	13
Chodatella quadriseta (Lemm.) G.M. Sm.	0	0	5	5	5
Closteriopsis longissima Lemm.	0	0	3	3	3

TAXA	Greater than 10%	PERCENT OCCURRENCE 9.9%-5.0%	4.9%-0.1%	Total	Index value
Kirchneriella obesa (W. West) Schmidle	0	0	4	4	4
Kirchneriella subsolitaria G.S. West	0	0	2	2	2
Quadrigula closterioides (Bohlin) Printz	0	0	2	2	2
Schroederia setigera (Schroed.) Lemm.	0	0	2	2	2
Selenastrum bibraianum Reinsch.	0	0	1	1	1
Tetraedron tumidulum (Reinsch.) Hansgirg.	0	0	1	1	1
Actinastrum hantzschii Lagerhm.	0	0	3	3	3
Crucigenia alternans G.M. Sm.	0	0	1	1	1
Crucigenia fenestrata Schmidle	0	0	1	1	1
Crucigenia irregularis Wille	0	0	4	4	4
Crucigenia lauterbornei Schmidle	0	0	1	1	1
Crucigenia quadrata Morren.	0	0	13	13	13
Crucigenia tetrapedia (Kirch.) W. & G.S. West	0	0	1	1	1
Scenedesmus adundans (Kirch.) Chodat	0	0	1	1	1
Scenedesmus bijuga (Turp.) Lagerhm.	0	0	9	9	9
Scenedesmus dimorphus (Turp.) Kutz.	0	0	7	7	7
Scenedesmus obliquus (Turp.) Kutz.	0	0	1	1	1
Scenedesmus quadricauda (Turp.) De Breb.	0	0	11	11	11
Order Zygnematales					
Spirogyra sp. Link.	0	0	1	1	1
Closterium strigosum Breb.	0	0	4	4	4
Cosmarium sp. Corda.	0	0	2	2	2
Staurastrum hexacerum (Ehr.) Wittrock	0	0	1	1	1
Staurastrum paradoxum Meyen.	0	0	1	1	1

TAXA	PERCENT OCCURRENCE Greater than 10%	9.9%-5.0%	4.9%-0.1%	Total	Index value
III. Division Chrysophycophyta					
Order Chrysomonadales					
Mallomonas caudata Ivanof.	0	0	2	2	2
Synura uvella Ehr.	0	0	5	5	5
Order Chromulinales					
Chrysococcus rufesens Klebs.	0	0	5	5	5
IV. Division Cryptophycophyta					
Order Cryptomondales					
unidentified cryptomonads	6	2	9	17	31
V. Division Cyanochloronta					
Order Chroococcales					
Anacystis-like organisms	0	0	5	5	5
Chroococcus-like organisms	0	1	6	7	8
Order Oscillatoriales					
Oscillatoria-like organisms	0	0	10	10	10
Anabeana-like organisms	0	0	6	6	6

TAXA	Greater than 10%	PERCENT OCCURRENCE 9.9%-5.0%	4.9%-0.1%	Total	Index value
VI. Division Euglenophycophyta Order Euglenales					
euglenoids	3	8	7	18	32
Phacus sp. Dujardin	0	0	1	1	1
Trachelomonas acuminata (Schmarda) Stein	0	0	1	1	1
Trachelomonas hispida (Perty) Stein	0	0	5	5	5
Trachelomonas smiewiki Swirenko	0	0	1	1	1
Trachelomonas urceolata Stokes	0	0	1	1	1
Trachelomonas volvocina Ehr.	0	0	9	9	9
VII. Division Pyrrhophycophyta Order Peridiniales					
Glenodinium cinctum (Mueller) Ehr.	0	0	3	3	3
Glenodinium gymnodinium Penard.	0	0	1	1	1
Glenodinium palustre (Lemm.) Schiller	0	0	2	2	2
Peridinium bipes Stein	0	0	1	1	1
Ceratium hirundinella (Mueller) Schrank	0	0	1	1	1
VIII. Division Xanthophycophyta Order Heterococcales					
Botryococcus sudeticus Lemm.	0	0	1	1	1
unidentified flagellates	0	0	3	3	3

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